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(54) **TURBINE BUCKET WITH NOTCHED SQUEALER TIP**

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F01D 5/20 (2006.01)

(52) **U.S. Cl.**
CPC ***F01D 5/20*** (2013.01); *F05D 2250/23* (2013.01); *F05D 2250/231* (2013.01); *F05D 2250/232* (2013.01); *F05D 2260/202* (2013.01)

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USPC .... 416/92, 97 R, 224, 228
See application file for complete search history.

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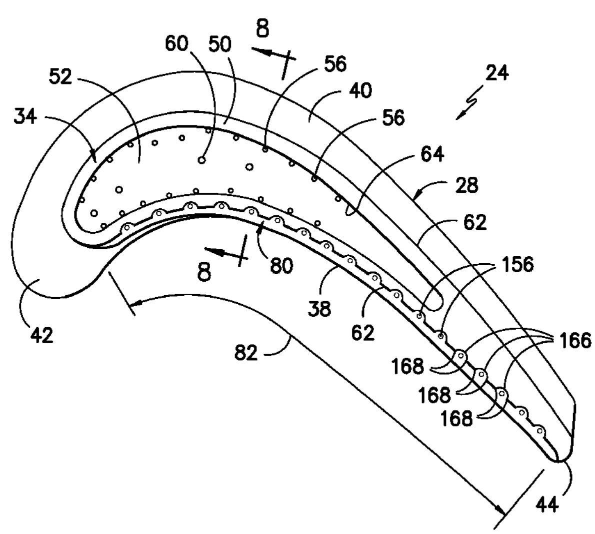
(57) **ABSTRACT**

A turbine bucket having an airfoil is disclosed. The airfoil may include a pressure side and a suction side extending between a leading edge and a trailing edge. In addition, the airfoil may include a tip. The tip may include a tip floor and a tip wall extending outwardly from the tip floor. The tip wall may include an inner surface defining an inner perimeter of the tip wall. Moreover, a plurality of notches may be defined by the inner surface around at least a portion of the inner perimeter.

20 Claims, 5 Drawing Sheets



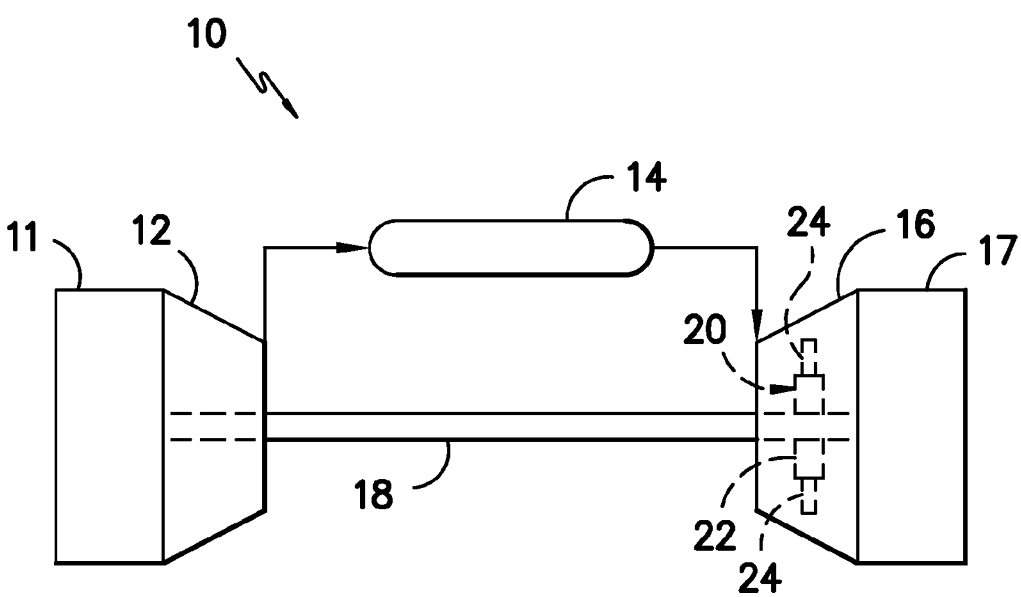


FIG. –1–

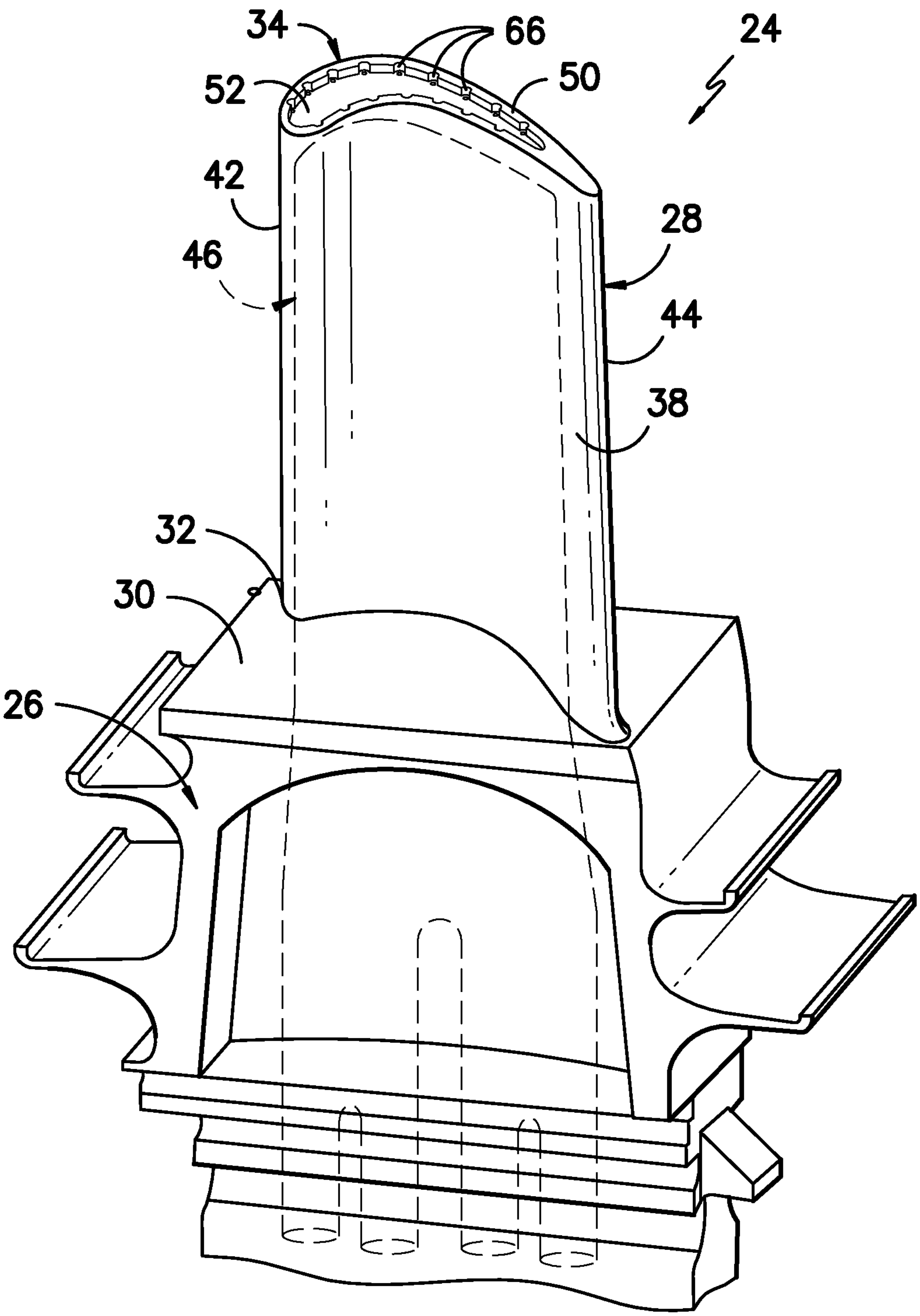
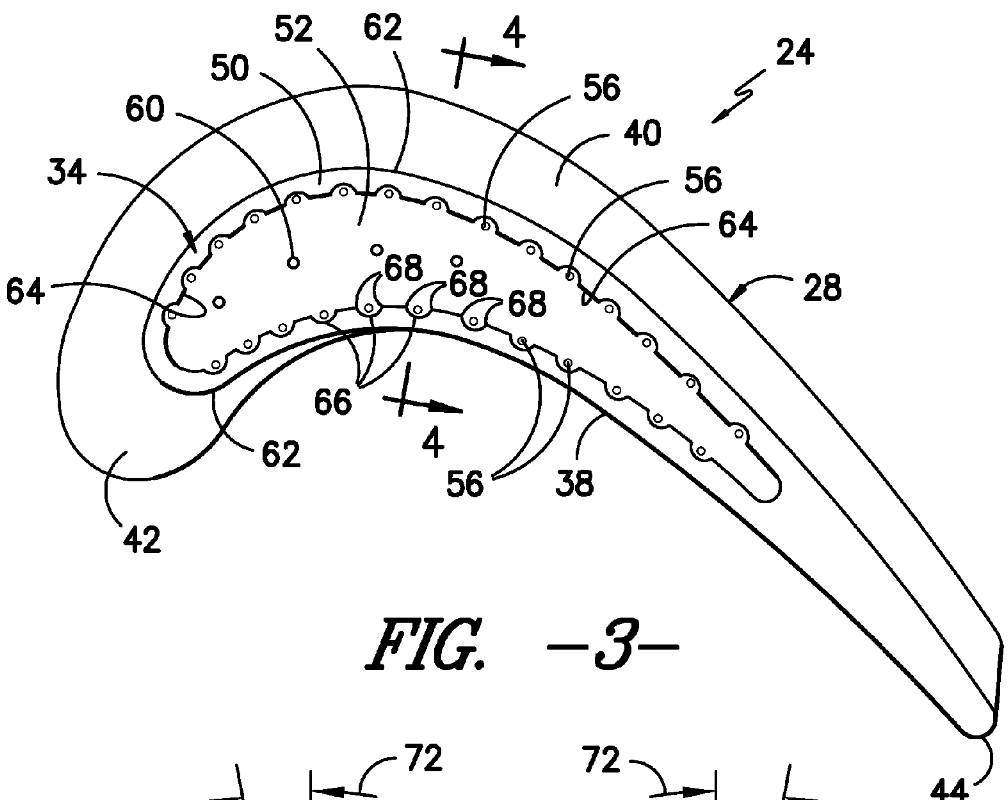


FIG. –2–



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44

FIG. –3–

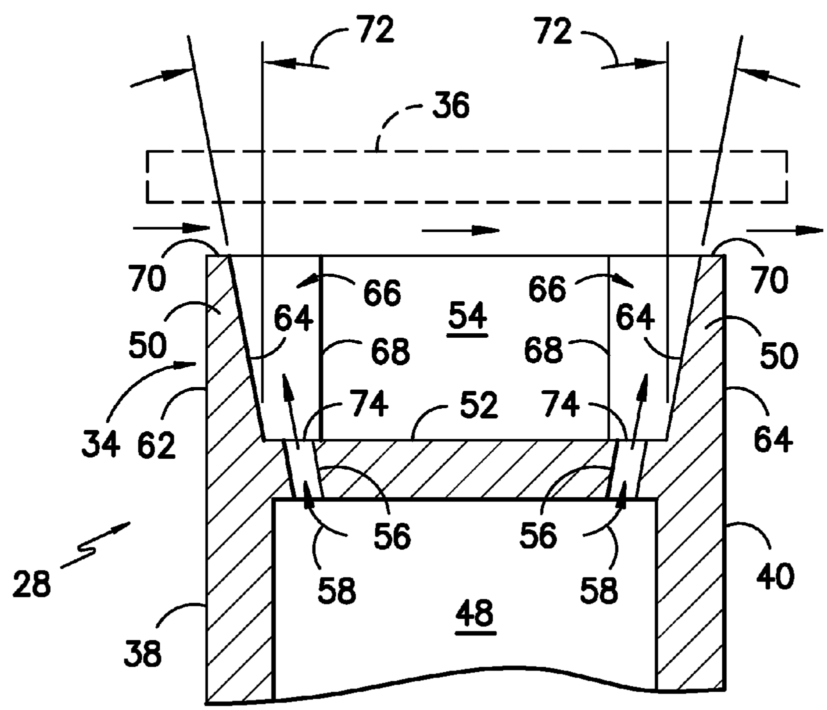

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FIG. –4–

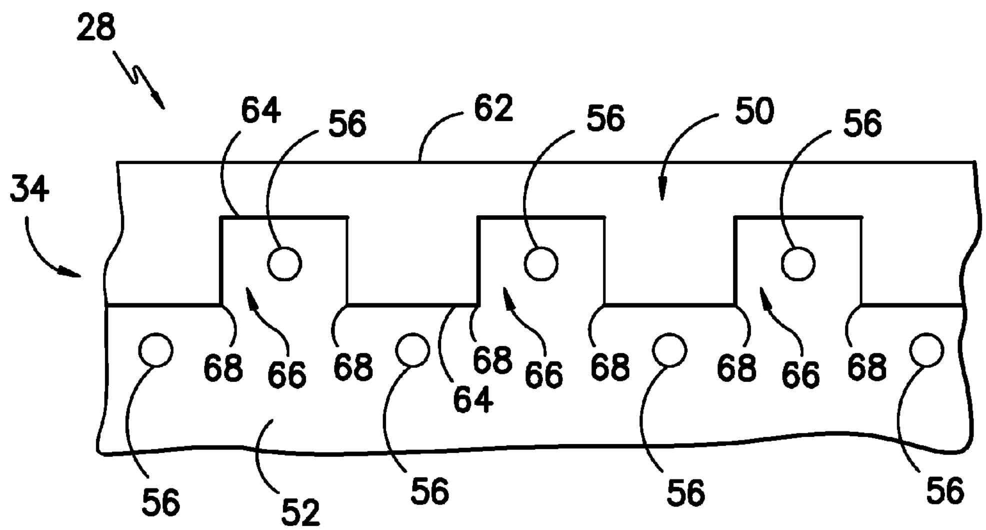
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FIG. –5–

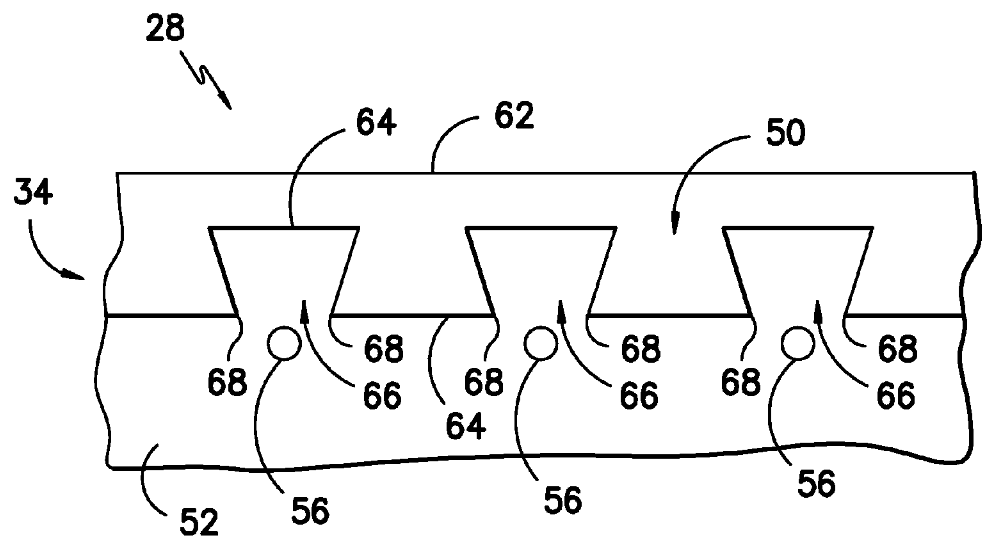
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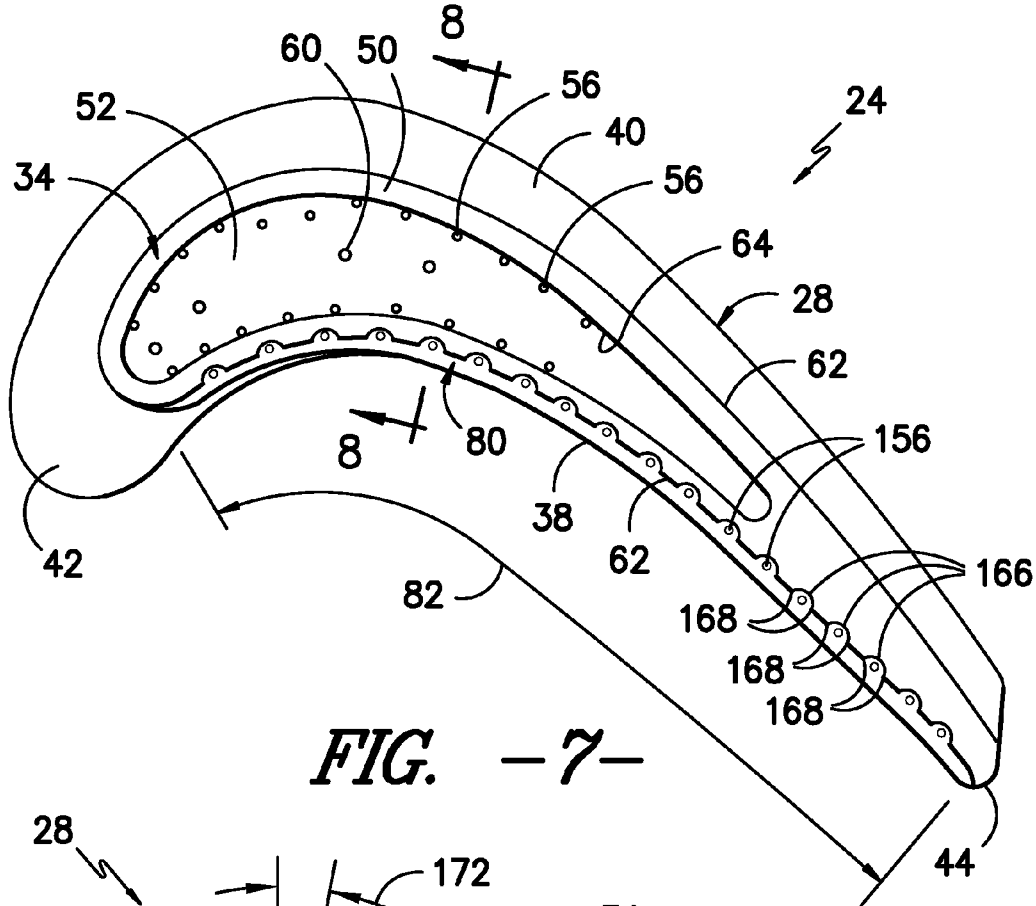
FIG. –6–


8
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56
52
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82
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FIG. –7–

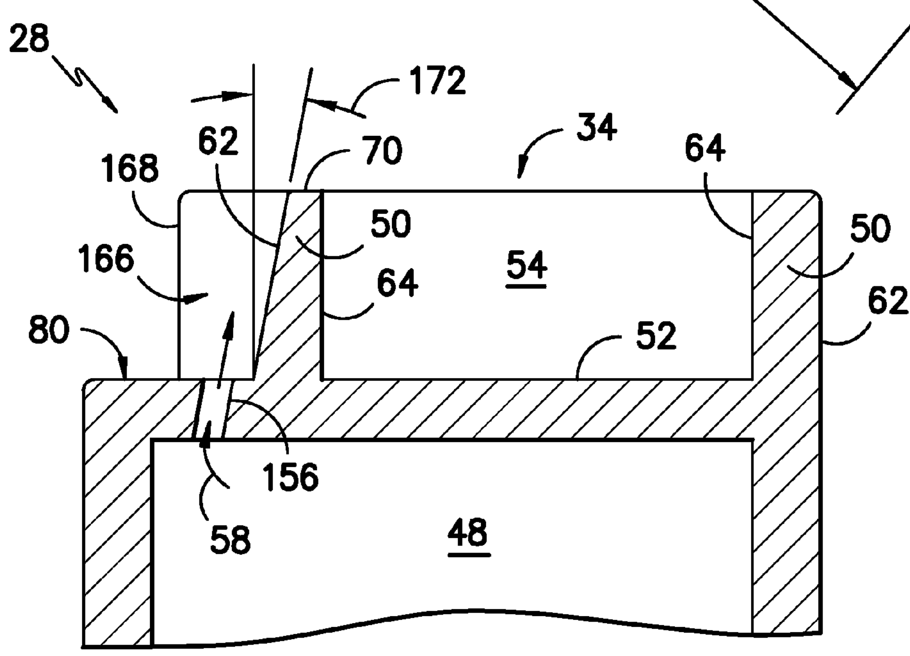
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FIG. –8–

TURBINE BUCKET WITH NOTCHED SQUEALER TIP

FIELD OF THE INVENTION

The present subject matter relates generally to turbine buckets and, more particular, to a notched squealer tip for a turbine bucket.

BACKGROUND OF THE INVENTION

In an air-ingesting turbo machine (e.g., a gas turbine), air is pressurized by a compressor and then mixed with fuel and ignited within an annular array of combustors to generate hot gases of combustion. The hot gases flow from each combustor through a transition piece for flow along an annular hot gas path. Turbine stages are typically disposed along the hot gas path such that the hot gases flow through first-stage nozzles and buckets and through the nozzles and buckets of follow-on turbine stages. The turbine buckets may be secured to a plurality of rotor disks comprising the turbine rotor, with each rotor disk being mounted to the rotor shaft for rotation therewith.

A turbine bucket generally includes an airfoil extending radially outwardly from a substantially planar platform and a shank portion extending radially inwardly from the platform for securing the bucket to one of the rotor disks. The tip of the airfoil is typically spaced radially inwardly from a stationary shroud of the turbo machine such that a small gap is defined between the tip and the shroud. This gap is typically sized as small as practical to minimize the flow of hot gases between the airfoil tip and the shroud.

In many instances, the tip of the airfoil may include a squealer tip wall extending around the perimeter of the airfoil so as to define a tip cavity and a tip floor therebetween. The squealer tip wall is generally used to reduce the size of the gap defined between the airfoil tip and the shroud. However, this creates an additional component of the turbine bucket that is subject to heating by the hot gas flowing around the airfoil. Thus, cooling holes are typically defined in the tip floor to allow a cooling medium to be directed from an airfoil cooling circuit within the airfoil to the tip cavity.

Accordingly, an improved tip configuration that allows for enhanced cooling of an airfoil tip would be welcomed in the technology.

BRIEF DESCRIPTION OF THE INVENTION

Aspects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention.

In one aspect, the present subject matter is directed to a turbine bucket including an airfoil. The airfoil may include a pressure side and a suction side extending between a leading edge and a trailing edge. In addition, the airfoil may include a tip. The tip may include a tip floor and a tip wall extending outwardly from the tip floor. The tip wall may include an inner surface defining an inner perimeter of the tip wall. Moreover, a plurality of notches may be defined by the inner surface around at least a portion of the inner perimeter.

In another aspect, the present subject matter is directed to a turbine bucket including an airfoil. The airfoil may include a pressure side and a suction side extending between a leading edge and a trailing edge. In addition, the airfoil may include a tip. The tip may include a tip floor and a tip wall extending outwardly from the tip floor. The tip wall may include an offset portion that is recessed relative to at least one of the pressure side or the suction side such that a tip shelf is defined at the offset portion. Moreover, a plurality of notches may be defined by the outer surface of the offset portion.

In a further aspect, the present subject matter is directed to a squealer tip for an airfoil. The squealer tip may include a tip floor and a tip wall extending outwardly from the tip floor along a pressure side and a suction side of the airfoil. The tip wall may include an inner surface defining an inner perimeter of the tip wall. In addition, a plurality of notches may be defined by the inner surface around at least a portion of the inner perimeter.

These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

FIG. **1** illustrates a schematic diagram of one embodiment of a turbo machine;

FIG. **2** illustrates a perspective view of one embodiment of a turbine bucket in accordance with aspects of the present subject matter;

FIG. **3** illustrates a top view of the turbine bucket shown in FIG. **2**, particularly illustrating an airfoil tip of the turbine bucket;

FIG. **4** illustrates a cross-sectional view of the airfoil tip shown in FIG. **3** taken along line **4-4**;

FIG. **5** illustrates a top, partial view of one embodiment of an airfoil tip configuration, particularly illustrating a top view of a portion of a tip wall and a tip floor of the airfoil tip;

FIG. **6** illustrates a top, partial view of another embodiment of an airfoil tip configuration, particularly illustrating a top view of a portion of a tip wall and a tip floor of the airfoil tip;

FIG. **7** illustrates a top view of another embodiment of a turbine bucket having an airfoil tip in accordance with aspects of the present subject matter;

FIG. **8** illustrates a cross-sectional view of the airfoil tip shown in FIG. **7** taken along line **8-8**.

DETAILED DESCRIPTION OF THE INVENTION

Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

In general, the present subject matter is directed to a turbine bucket having an improved squealer tip. Specifically, in several embodiments, the squealer tip may include a tip floor and a notched tip wall extending outwardly from the tip floor. For instance, in one embodiment, the inner surface of the tip wall may define a plurality of notches around the inner perimeter of the tip wall. Additionally, a plurality of cooling holes may be defined in the tip floor for supplying a cooling medium (e.g., air, water, steam) to the squealer tip. For example, the cooling holes may be defined in the tip floor so as to be aligned with the notches, such as by being positioned within the notches.

In alternative embodiments, the outer surface of the tip wall may define a plurality of notches. For instance, in several embodiments, a portion of the tip wall may be recessed such that a tip shelf is formed along the pressure side and/or suction side of the squealer tip. In such embodiments, the notches may be defined around the outer perimeter of the recessed portion of the tip wall. Additionally, a plurality of cooling holes may be defined in the tip shelf for supplying a cooling medium to the squealer tip.

It should be appreciated that numerous advantages may be provided by the disclosed notched tip wall. For example, the notches may provide an increased surface area for cooling the tip wall. In addition, the notches may also provide a means for forming angled cooling holes within the tip floor and/or the tip shelf. For instance, as will be described below, the notches may be angled relative to the tip floor and/or the tip shelf. As such, angled cooling holes may be formed within the notches without the need to use custom tooling and/or specialized manufacturing processes. Such angled cooling holes may allow for cooling medium to be diverted directly against the inner and/or outer surface of the tip wall, thereby providing enhanced cooling for the tip wall.

Referring now to the drawings, FIG. **1** illustrates a schematic diagram of one embodiment of an air-ingesting turbo machine **10**. The turbo machine **10** generally includes an inlet section **11**, a compressor section **12** disposed downstream of the inlet section **11**, a plurality of combustors (not shown) within a combustor section **14** disposed downstream of the compressor section **12**, a turbine section **16** disposed downstream of the combustor section **14** and an exhaust section **17** disposed downstream of the turbine section **16**. Additionally, the turbo machine **10** may include a shaft **18** coupled between the compressor section **12** and the turbine section **16**. The turbine section **16** may generally include a turbine rotor **20** having a plurality of rotor disks **22** (one of which is shown) and a plurality of turbine buckets **24** extending radially outwardly from and being coupled to each rotor disk **22** for rotation therewith. Each rotor disk **22** may, in turn, be coupled to a portion of the shaft **18** extending through the turbine section **16**.

During operation of the turbo machine **10**, the compressor section **12** pressurizes air entering the machine **10** through the inlet section **11** and supplies the pressurized air to the combustors of the combustor section **14**. The pressurized air is mixed with fuel and burned within each combustor to produce hot gases of combustion. The hot gases of combustion flow in a hot gas path from the combustor section **14** to the turbine section **16**, wherein energy is extracted from the hot gases by the turbine buckets **24**. The energy extracted by the turbine buckets **24** is used to rotate the rotor disks **22** which may, in turn, rotate the shaft **18**. The mechanical rotational energy may then be used to power the compressor section **12** and generate electricity. The hot gases exiting the

turbine section **16** may then be exhausted from the machine **10** via the exhaust section **17**.

Referring now to FIGS. **2-4**, one embodiment of a turbine bucket **24** is illustrated in accordance with aspects of the present subject matter. In particular, FIG. **2** illustrates a perspective view of the turbine bucket **24**. FIG. **3** illustrates a top view of the turbine bucket **24**. Additionally, FIG. **4** illustrates a partial, cross-sectional view of the turbine bucket **24** taken along line **4-4** (FIG. **3**).

As shown, the turbine bucket **24** generally includes a shank portion **26** and an airfoil **28** extending from a substantially planar platform **30**. The platform **30** generally serves as the radially inward boundary for the hot gases of combustion flowing through the turbine section **16** of the turbo machine **10** (FIG. **1**). The shank portion **26** may generally be configured to extend radially inwardly from the platform **30** and may include a root structure (not shown), such as a dovetail, configured to secure the bucket **24** to the rotor disk **22** of the turbo machine **10** (FIG. **1**).

The airfoil **28** may generally extend radially outwardly from the platform **30** and may include an airfoil base **32** disposed at the platform **30** and an airfoil tip **34** disposed opposite the airfoil base **32**. As such, the airfoil tip **34** may generally define the radially outermost portion of the turbine bucket **24** and, thus, may be configured to be positioned adjacent to a stationary shroud **36** (shown in dashed lines in FIG. **4**) of the turbo machine **10**. The airfoil **28** may also include a pressure side **38** and a suction side **40** (FIGS. **3** and **4**) extending between a leading edge **42** and a trailing edge **44**. The pressure side **38** may generally comprise an aerodynamic, concave outer surface of the airfoil **28**. Similarly, the suction side **40** may generally define an aerodynamic, convex outer surface of the airfoil **28**.

Additionally, the turbine bucket **24** may also include an airfoil cooling circuit **46** (shown in dashed lines in FIG. **2**) extending radially outwardly from the shank portion **26** for flowing a cooling medium (e.g., air, water, steam or any other suitable fluid), throughout the airfoil **28**. The airfoil circuit **46** may generally have any suitable configuration known in the art. Thus, in several embodiments, the airfoil circuit **46** may include a plurality of channels or passages **48** (one of which is shown in the cross-sectional view of FIG. **4**) extending radially within the airfoil **28**, such as from the airfoil base **32** to a location generally adjacent the airfoil tip **34**. For example, in one embodiment, the airfoil circuit **46** may be configured as a multiple-pass cooling circuit, with the passages **48** being interconnected and extending radially inward and radially outward within the airfoil **28** (e.g., in a serpentine-like path) such that the cooling medium within the passages **48** flows alternately radially outwardly and radially inwardly throughout the airfoil **28**.

Referring particularly to FIGS. **3** and **4**, in several embodiments, the airfoil tip **34** may be configured as a squealer tip. As such, the airfoil tip **34** may include a tip wall **50** extending radially outwardly from a tip floor **52**, thereby defining a squealer tip cavity **54** (FIG. **4**). As particularly shown in FIG. **4**, the tip floor **52** may generally define a radially outer boundary for cooling passages **48** of the airfoil circuit **46**. In addition, the tip floor **52** may define a plurality of cooling holes **56** for directing the cooling medium (indicated by arrows **58**) flowing within the cooling passages **48** into the tip cavity **54**. For instance, as shown in FIGS. **3** and **4**, the cooling holes **56** may be spaced apart along the tip floor **52** at locations generally adjacent to the pressure and suction sides of the tip wall **50**. As such, the cooling medium **58** flowing through the cooling holes **56** may be directed around the inner perimeter of the tip wall to provide impingement and/or film cooling to the airfoil tip **34**.

It should be appreciated one or more dust holes **60** may also be defined through the tip floor **52** for expelling dust and/or other debris contained within the cooling medium supplied through the airfoil circuit **46**. For example, as shown in FIG. **3**, the dust holes **60** may be defined in the tip floor **52** at a generally central location between the pressure and suction sides of the tip wall **50** so as to align the dust holes **60** with the cooling passages **48** of the airfoil circuit **46**. As such, any dust and/or debris carried within cooling medium may be expelled from the cooling passages **48** through the dust holes **60**.

The tip wall **50** of the airfoil tip **34** may generally be configured to for an extension of the airfoil **28**. For example, as shown in FIG. **4**, the tip wall **50** may be formed integrally with the airfoil **28** and may extend radially outwardly from the tip floor **52** along the pressure and suction sides **38**, **40** of the airfoil **28**. Additionally, as shown in FIG. **3**, the tip wall **50** may generally extend between the leading and trailing edges **42**, **44** of the airfoil **28** so as to define a continuous wall around the perimeter of the airfoil **28**. As such, an outer surface **62** of the tip wall **50** (defining an outer perimeter of the tip wall **50**) may generally form part of the pressure and suction sides **38**, **40** of the airfoil **28** while an inner surface **64** of the tip wall **50** (defining an inner perimeter of the tip wall **50**) may generally define the boundary of the tip cavity **54**.

Additionally, in several embodiments, the tip wall **50** may be notched around at least a portion of its inner perimeter. Specifically, as shown in FIGS. **3** and **4**, sections of the inner surface **64** may be configured to extend outwardly towards the outer surface **62** of the tip wall **50**, thereby defining notches **66** in the inner perimeter of the tip wall **50** between opposed notch edges **68** of the inner surface **64**. In several embodiments, the notches **66** may be defined around the inner perimeter of the tip wall **50** on both the pressure and suction sides **38**, **40** of the airfoil **28**. However, in other embodiments, the notches **66** may be defined may be defined around the inner perimeter of the tip wall **50** on only the pressure side **38** or the suction side **40** of the airfoil **28**.

In general, the notches **66** may be formed in the tip wall **50** so as to define any suitable shape. For example, as shown in FIG. **3**, the notches **66** may define a semi-elliptical shape (e.g. a semi-circular shape). Alternatively, as shown in FIG. **5**, the notches may be formed in the tip wall **50** so as to define a rectangular shape (e.g., a square shape). In another embodiment, as shown in FIG. **6**, the notches **66** may define a trapezoidal shape. In further embodiments, the notches **66** may define any other suitable shape, such as a triangular shape or any other suitable shape having straight and/or curved sides.

Additionally, as shown in FIG. **4**, each notch **66** defined by the inner surface **64** may generally extend radially between the tip floor **52** and a top surface **70** of the tip wall **50**. In one embodiment, the notches **66** may be configured to extend perpendicularly between the tip floor **52** and the top surface **70**. Alternatively, the notches **66** may be configured to extend at an angle **72** between the tip floor **52** and the top surface **70**. For instance, as shown in FIG. **4**, the notches **66** may angled outwardly from the tip floor **52** in the direction of the outer surface **62** of the tip wall **50**. It should be appreciated that the angle **72** defined by each notch **66** as it extends between the tip floor **52** and the top surface **70** of the tip wall **50** may generally be any suitable angle. However, in particular embodiment, the angle **72** may range from about 1 degree to about 30 degrees, such as from about 2 degrees to about 15 degrees or from about 2 degrees to about 20 degrees and all other subranges therebetween.

Moreover, in several embodiments, the cooling holes **56** defined in the tip floor **52** may be aligned with the notches **66** defined in the tip wall **50**. For example, as shown in FIGS. **3** and **4**, in one embodiment, the cooling holes **56** may be defined in the tip floor **52** so as to be positioned within the notches **66**. As described herein, a cooling hole **56** is positioned within a notch **66** if at least a portion of an outlet **74** of the cooling hole **56** is disposed in the area defined by such notch **66** (i.e., the area defined between the notch edges **68** of each notch **66**). For example, as shown in FIG. **4**, the outlets **74** of the cooling holes **56** are disposed inside the notch edges **68** and, thus, are positioned within the notches **66**.

In other embodiments, the cooling holes **56** may be defined in the tip floor **52** at any other suitable position relative to the notches **66**. For example, the cooling holes **56** may be defined in the tip floor **52** so as to be positioned outside the notches **66** (i.e., at a location outside the area defined between the notch edges **68** the notches **66**). Specifically, as shown in FIG. **5**, in one embodiment, the cooling holes **56** may be defined in the tip floor **52** so as to be positioned between the notches **66** (e.g., by positioning each cooling hole **56** between the notch edges **68** of adjacent notches **66**). Alternatively, as shown in FIG. **6**, the cooling holes **56** may be defined in the tip floor **52** so as to be aligned with the notches **66** at locations outside the notch edges **68**. In addition, it should be appreciated that the cooling holes **56** may be positioned both inside and outside the notches **66**. For example, as shown in FIG. **5**, a first portion of the cooling holes **56** may be defined in the tip floor **52** so as to be positioned within the notches **66** while a second portion of the cooling holes may be defined in the tip floor **52** so as to be positioned between the notches **66**.

Additionally, in several embodiments, the cooling holes **56** may be oriented perpendicularly or non-perpendicularly within the tip floor **52**. Specifically, in one embodiment, the cooling holes **56** may be angled relative to the tip wall **50**. For instance, as shown in FIG. **4**, the cooling holes **56** may be angled towards the tip wall **50** (e.g., at the same or a different angle as the angle **72** of the notches **66**) such that the cooling medium **58** supplied through the cooling holes **56** is directed against the inner surface **64** of the tip wall **50**, thereby providing beneficial cooling to the tip wall **50**. However, in other embodiments, the cooling holes **56** may be defined perpendicularly within the tip floor **52** and, thus, may extend generally parallel to the tip wall **50**.

It should be appreciated that, by angling the notches **66** as described above, the angled cooling holes **56** shown in FIG. **5** may be quickly and easily formed within the tip floor **52**. For instance, by appropriately angling the notches **66**, angled cooling holes **56** may be drilled or otherwise formed in the tip floor **52** using standard equipment and/or processes (e.g., a straight drill bit).

Referring now to FIGS. **7** and **8**, another embodiment of airfoil tip configuration is illustrated in accordance with aspects of the present subject matter. In particular, FIG. **7** illustrates a top view of one embodiment of an airfoil **28** of a turbine bucket **24**, particularly illustrating the airfoil **28** including a tip shelf **80** defined at the airfoil tip **34**. In addition, FIG. **8** illustrates a partial, cross-sectional view of the airfoil **28** shown in FIG. **7** about line **8-8**.

As shown, the tip wall **50** may include an offset portion **82** that is recessed relative to the pressure and/or suction sides **38**, **40** of the airfoil **28**, thereby forming a tip shelf **80** adjacent to such offset portion **82**. For example, as shown in

FIGS. **7** and **8**, the offset portion **82** of the tip wall **50** may be positioned on the pressure side **38** of the airfoil **28** such that the tip shelf **80** forms an extension of the tip floor **52** along the pressure side **38**. However, in other embodiments, the offset portion **82** of the tip wall **50** may be positioned on the suction side **40** of the airfoil **28** such that the tip shelf **80** forms an extension of the tip floor **52** along the suction side **40**.

In several embodiments, when a tip shelf **80** is formed in the airfoil tip **34**, the outer perimeter of the tip wall **50** may be notched around the portion of the tip wall **50** defined by the offset portion **82**. Specifically, as shown in FIGS. **7** and **8**, sections of the outer surface **62** of the tip wall **50** forming the offset portion **82** may be configured to extend inwardly towards the inner surface **64** of the tip wall **50**, thereby defining notches **166** in the outer perimeter of the tip wall **50** between opposed notch edges **168** of the outer surface **64**. In general, the notches **166** formed around the outer perimeter of the tip wall **50** may be configured the same as or similar to the notches **66** described above with reference to FIGS. **2-6**. For example, the notches **166** may be configured to define any suitable shape (e.g., a semi-elliptical shape, a rectangular shape, a trapezoidal shape, a triangular shape and/or any other suitable shape). Additionally, in several embodiments, the notches **166** may be configured to extend at an angle **172** between the tip floor **52** and the top surface **70** of the tip wall **50**.

Moreover, a plurality of cooling holes **156** may also be defined in the tip shelf **80** for directing a cooling medium (indicated by arrows **58**) from the passages **48** of the airfoil cooling circuit **46** to the offset portion **82** of the tip wall **50**. For example, as shown in FIG. **8**, the cooling holes **56** may be defined through the tip shelf **80** such that at least a portion of the cooling medium **58** flowing within the airfoil **28** may be directed around the outer perimeter of the tip wall **50**. In general, the cooling holes **156** defined in the tip shelf **80** may be configured the same as or similar to the cooling holes **56** described above with reference to FIGS. **2-6**. For instance, in several embodiments, the cooling holes **156** may be aligned with the notches **166** defined in the tip wall **50**, such as by being positioned within the notches **166** (e.g., by defining the cooling holes **156** within the area defined between the notch edges **168** of each notch **166**). Alternatively, the cooling holes **156** may be defined in the tip shelf **80** so as to be positioned between the notches **166**. Additionally, in several embodiments, the cooling holes **156** may be oriented non-perpendicularly within the tip floor **52**. For instance, as shown in FIG. **8**, the cooling holes **156** may be angled towards the tip wall **50** (e.g., at the same or a different angle as the angle **172** of the notches **166**) such that the cooling medium **58** supplied through the cooling holes **156** is directed against the outer surface **62** of the tip wall **50**, thereby providing beneficial cooling to the tip wall **50**.

It should be appreciated that, in additional embodiments of the present subject matter, the disclosed notches **66**, **166** may be formed around portions of both the inner and outer perimeters of the tip wall **50**. For example, in the embodiment shown in FIGS. **7** and **8**, in addition to the notches **166** defined by the outer surface **62** of the tip wall **50**, a plurality of notches **66** may also be defined by the inner surface **64** of the tip wall as shown in FIGS. **2-6**.

This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A turbine bucket comprising:

an airfoil including a pressure side and a suction side extending between a leading edge and a trailing edge, the airfoil further including a tip, the tip comprising:

a tip floor; and

a tip wall extending outwardly from the tip floor, the tip wall including an offset portion that is recessed relative to at least one of the pressure side or the suction side such that a tip shelf is defined at the offset portion, the offset portion of the tip wall defining an outer surface,

wherein a plurality of notches are defined by the outer surface of the offset portion of the tip wall, each of the plurality of notches being defined between opposed notch edges of the outer surface and extending radially between the tip shelf and a top surface of the tip wall,

wherein a plurality of cooling holes are defined in the tip shelf, a first cooling hole of the plurality of cooling holes being aligned with a first notch of the plurality of notches, the first cooling hole defining an outlet at the tip shelf for directing a cooling medium from an internal cooling circuit of the airfoil to an exterior of the airfoil,

wherein the first cooling hole extends lengthwise between the internal cooling circuit and the tip shelf such that the first cooling hole is angled towards the outer surface of the offset portion of the tip wall.

2. The turbine bucket of claim **1**, wherein the offset portion of the tip wall is disposed on the pressure side of the airfoil.

3. The turbine bucket of claim **1**, wherein each of the plurality of notches extends at an angle along the outer surface of the offset portion of the tip wall between the tip floor and the top surface of the tip wall.

4. The turbine bucket of claim **3**, wherein the angle ranges from 1 degree to 30 degrees.

5. The turbine bucket of claim **3**, wherein the outer surface of the offset portion of the tip wall and the first cooling hole are angled in the same direction.

6. The turbine bucket of claim **1**, wherein at least one cooling hole of the plurality of cooling holes is defined in the tip shelf so as to be positioned between two notches of the plurality of notches.

7. The turbine bucket of claim **1**, wherein the outlet of the first cooling hole defines a dimensional parameter that is smaller than an area defined between the opposed notch edges of the first notch.

8. The turbine bucket of claim **7**, wherein the outlet of the first cooling hole is spaced apart from the first notch along the tip shelf such that portions of the tip shelf extend outwardly from the outlet around an entire perimeter of the outlet.

9. The turbine bucket of claim **7**, wherein the dimensional parameter corresponds to a cross-sectional area of the outlet at the tip shelf.

10. The turbine bucket of claim **7**, wherein the outlet of the first cooling hole is positioned entirely within the area defined between the opposed notch edges of the first notch.

11. The turbine bucket of claim **10**, wherein the area is defined between the opposed notch edges at a radial location at which the first notch intersects the top surface of the tip wall.

12. The turbine bucket of claim **7**, wherein the outlet of the first cooling hole is positioned entirely outside the area defined between the opposed notch edges of the first notch.

13. A squealer tip for an airfoil, the squealer tip comprising:

a tip floor; and

a tip wall extending outwardly from the tip floor, the tip wall including an offset portion that is recessed relative to at least one of the pressure side or the suction side such that a tip shelf is defined at the offset portion, the offset portion of the tip wall defining an outer surface,

wherein a plurality of notches are defined by the outer surface of the offset portion of the tip wall, each of the plurality of notches being defined between opposed notch edges of the outer surface and extending radially between the tip shelf and a top surface of the tip wall,

wherein a plurality of cooling holes are defined in the tip shelf, a first cooling hole of the plurality of cooling holes being aligned with a first notch of the plurality of notches, the first cooling hole defining an outlet at the tip shelf for directing a cooling medium from an internal cooling circuit of the airfoil to an exterior of the airfoil,

wherein the first cooling hole extends lengthwise between the internal cooling circuit and the tip shelf such that the first cooling hole is angled towards the outer surface of the offset portion of the tip wall.

14. The squealer tip of claim **13**, wherein each of the plurality of notches extends at an angle along the outer surface of the offset portion of the tip wall between the tip floor and the top surface of the tip wall.

15. The squealer tip of claim **14**, wherein the angle ranges from 1 degree to 30 degrees.

16. The squealer tip of claim **14**, wherein the outer surface of the outer portion of the tip wall and the first cooling hole are angled in the same direction.

17. The squealer tip of claim **13**, wherein the outlet of the first cooling hole defines a dimensional parameter that is smaller than an area defined between the opposed notch edges of the first notch.

18. The squealer tip of claim **17**, wherein the outlet of the first cooling hole is spaced apart from the first notch along the tip shelf such that portions of the tip shelf extend outwardly from the outlet around an entire perimeter of the outlet.

19. The squealer tip of claim **13**, wherein the outlet of the first cooling hole is positioned entirely within or entirely outside the area defined between the opposed notch edges of the first notch.

20. The squealer tip of claim **19**, wherein the outlet of the first cooling hole is positioned entirely within the area defined between the opposed notch edges of the first notch, the area being defined between the opposed notch edges at a radial location at which the first notch intersects the top surface of the tip wall.

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